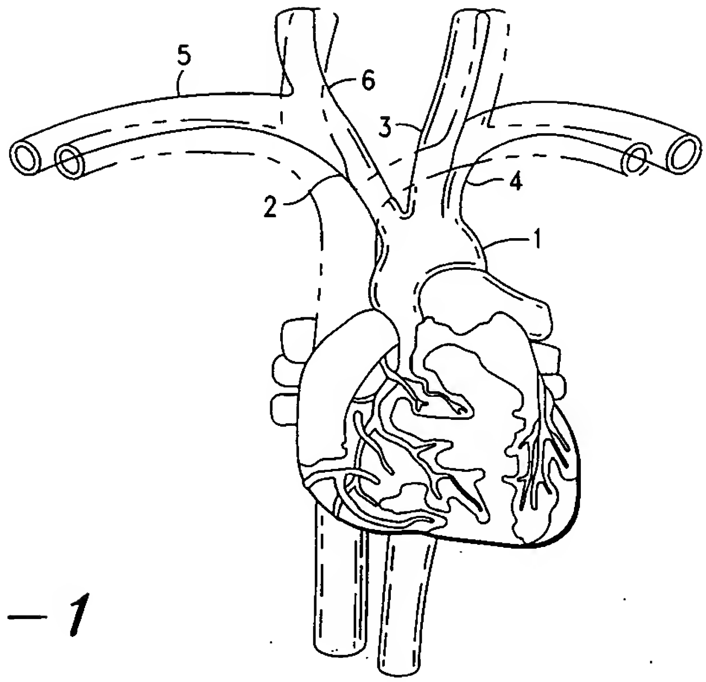


FIG.—1

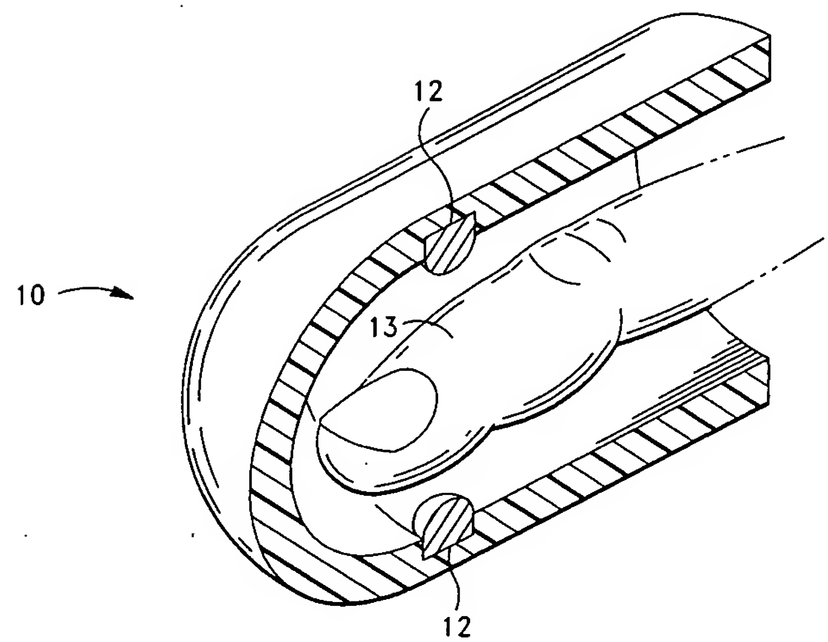


FIG.—2

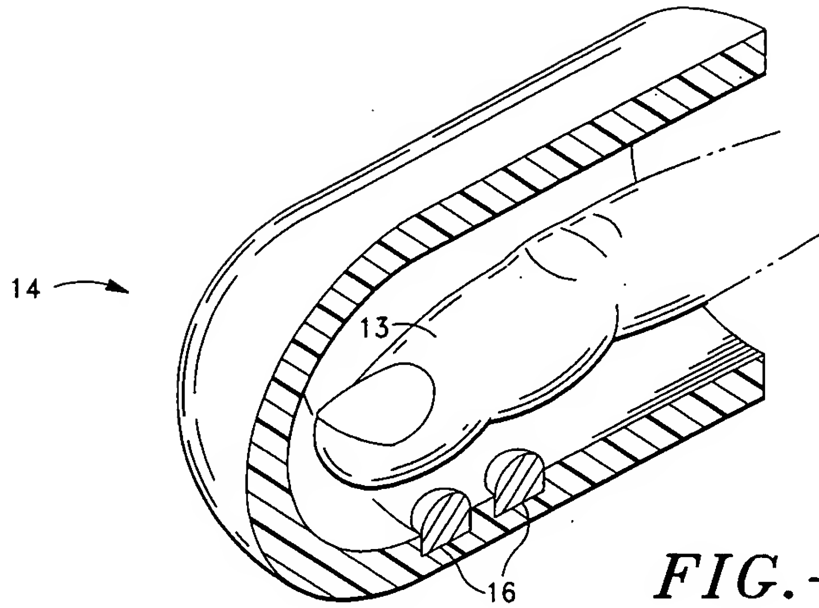


FIG.—3

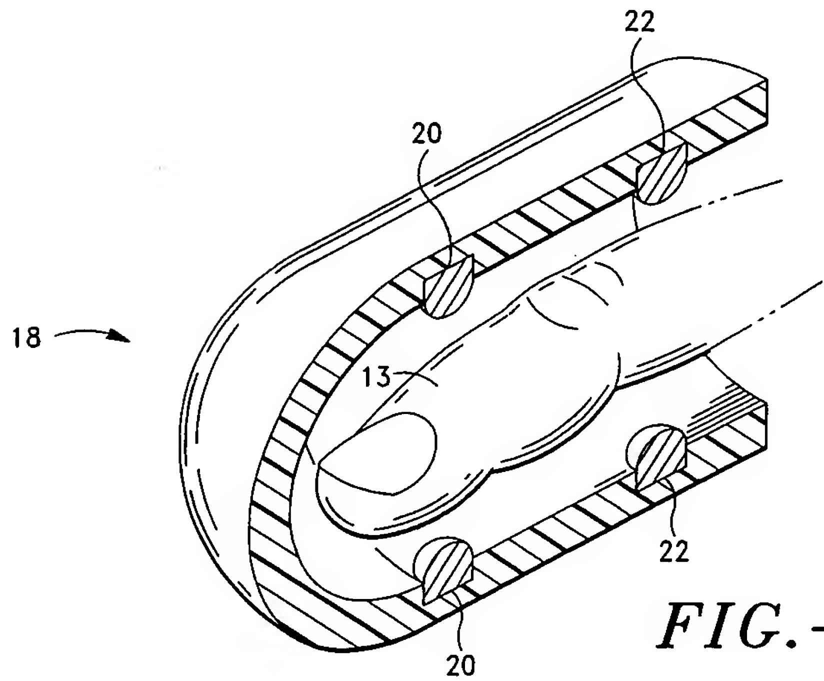


FIG.—4

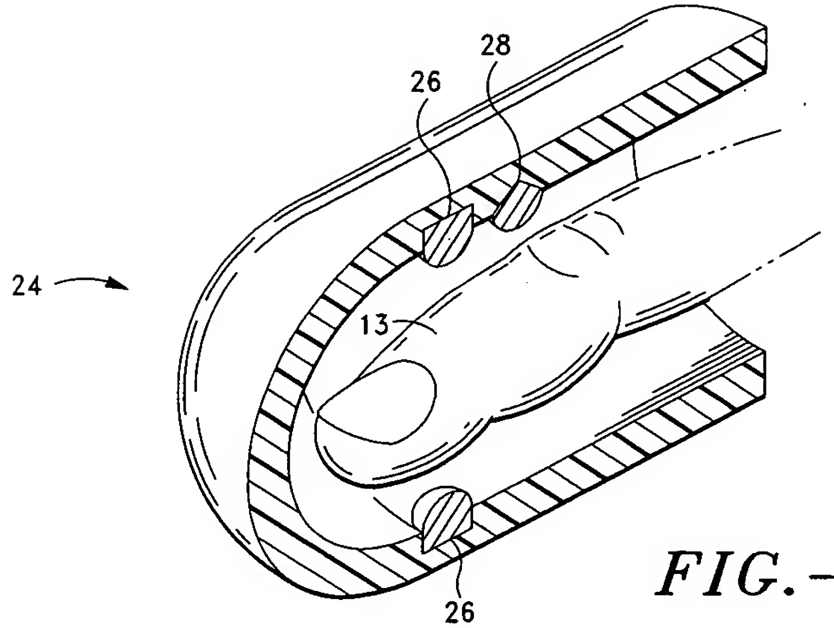


FIG.—5

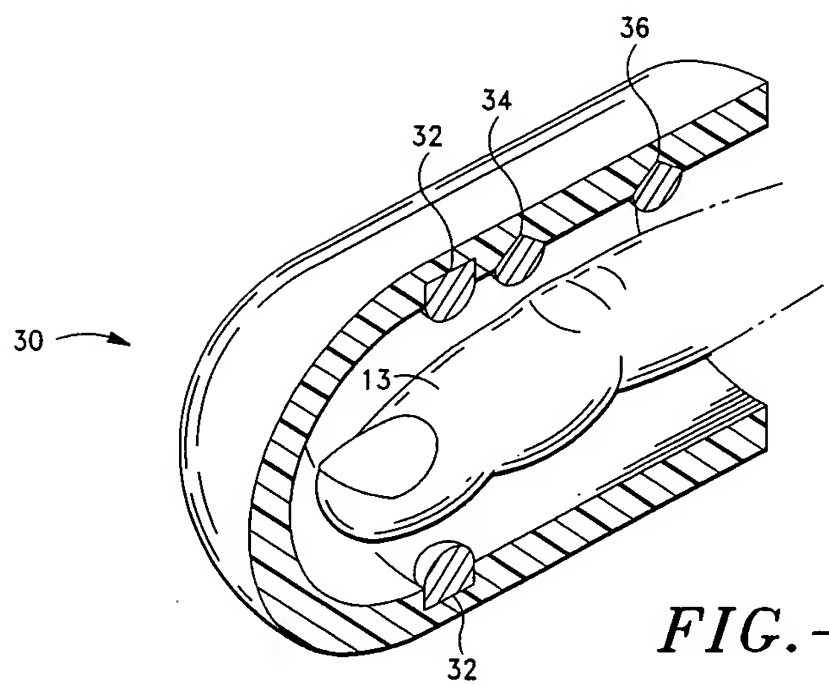


FIG.—6

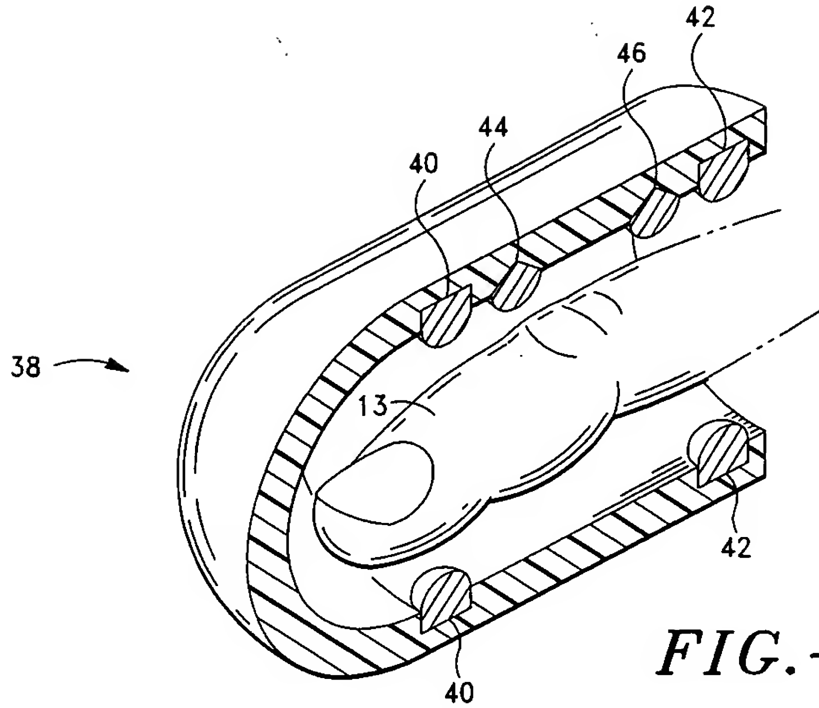


FIG.-7

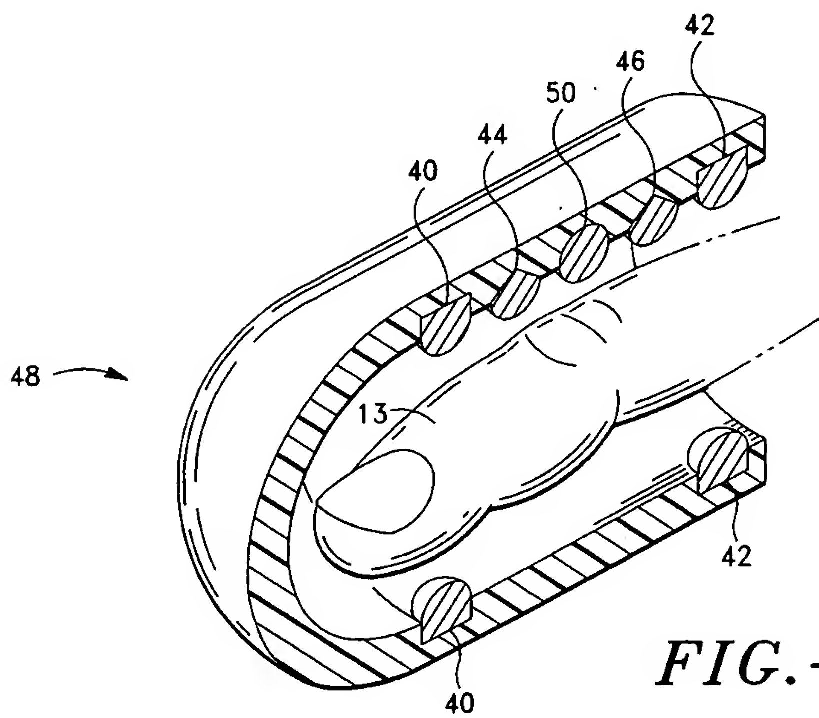


FIG.-8

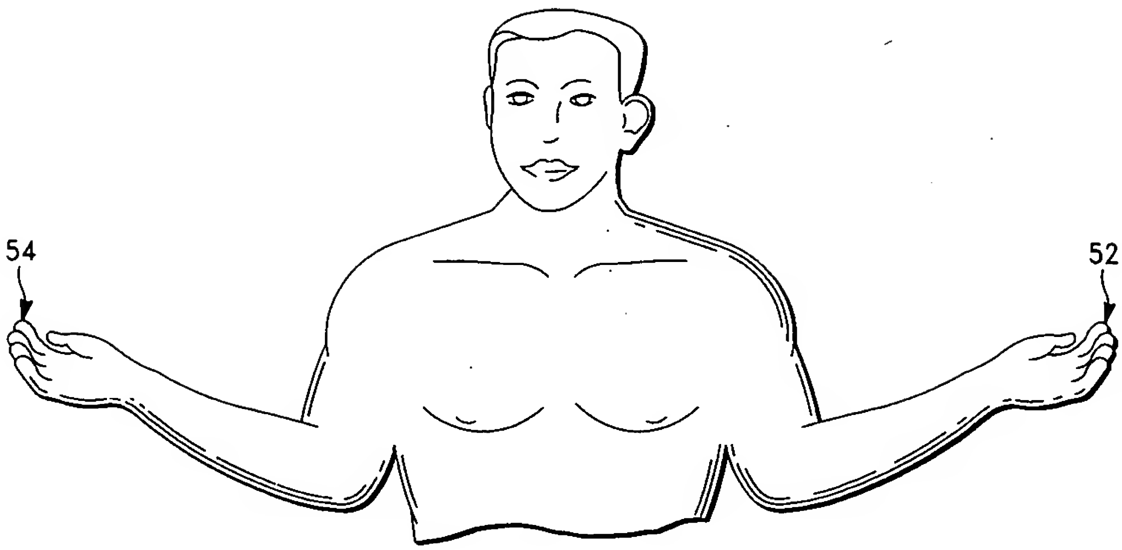


FIG.–9

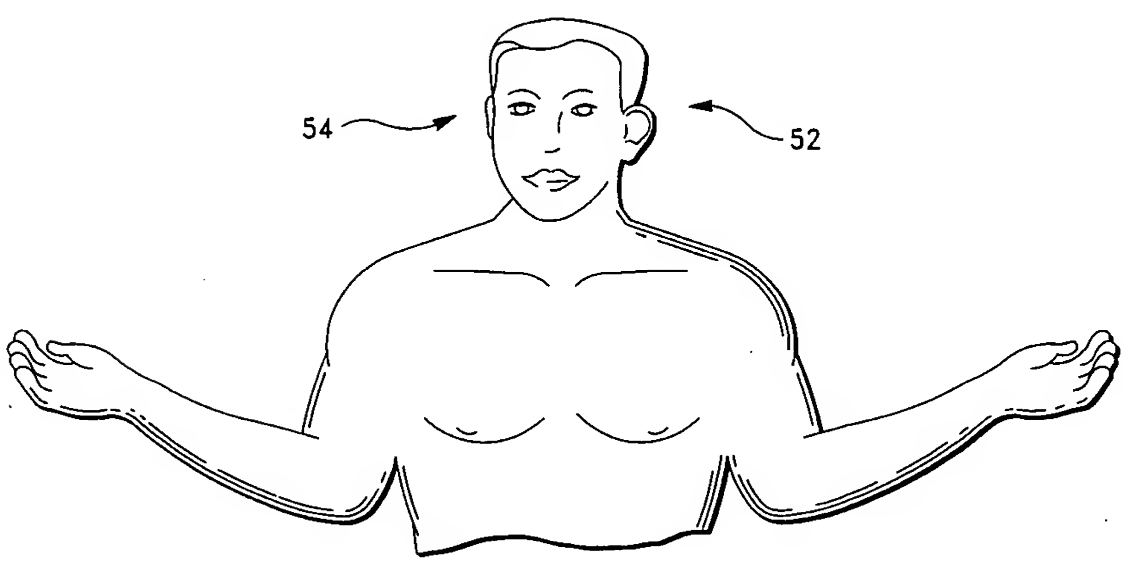


FIG.–10

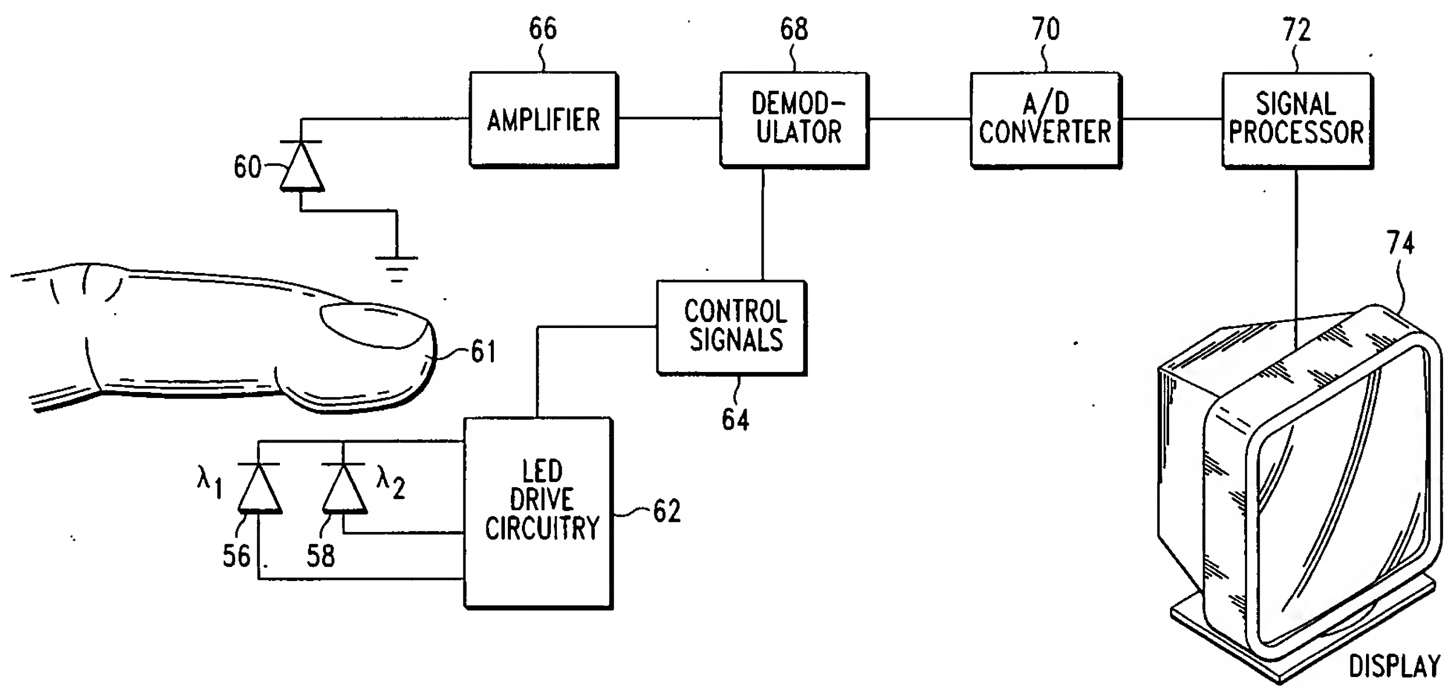

66
AMPLIFIER
68
DEMOD-
ULATOR
70
A/D
CONVERTER
72
SIGNAL
PROCESSOR
60
61
CONTROL
SIGNALS
64
74
LED
DRIVE
CIRCUITRY
62
λ1
λ2
56
58
DISPLAY

FIG.—11

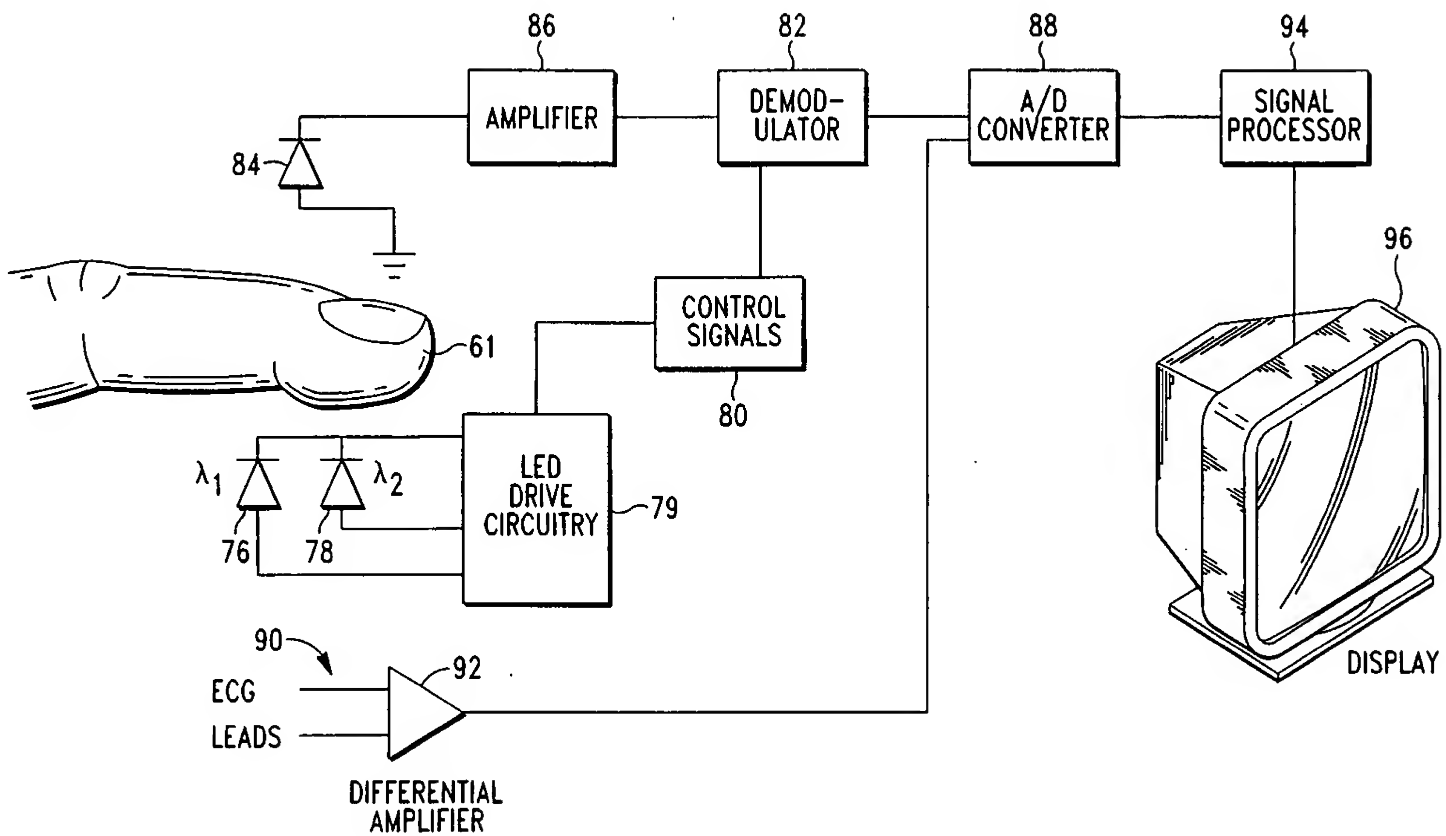
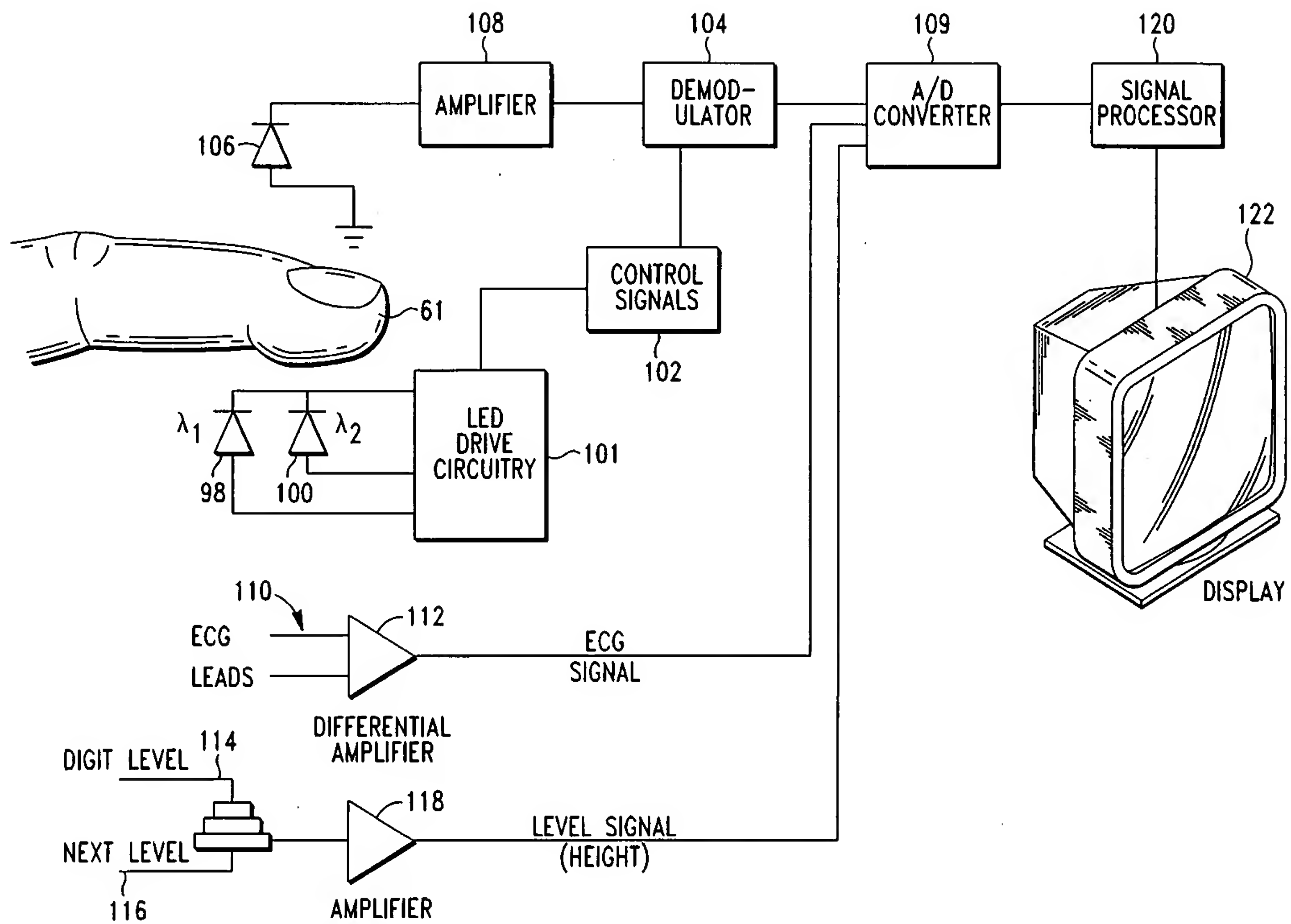

86
AMPLIFIER
82
DEMOD-
ULATOR
88
A/D
CONVERTER
94
SIGNAL
PROCESSOR
84
61
CONTROL
SIGNALS
80
96
λ_1
λ_2
76
78
LED
DRIVE
CIRCUITRY
79
90
92
ECG
LEADS
DIFFERENTIAL
AMPLIFIER
DISPLAY

FIG.-12



108
AMPLIFIER
104
DEMOD-
ULATOR
109
A/D
CONVERTER
120
SIGNAL
PROCESSOR
106
61
CONTROL
SIGNALS
102
122
λ1
λ2
98
100
LED
DRIVE
CIRCUITRY
101
DISPLAY
110
ECG
LEADS
112
ECG
SIGNAL
DIFFERENTIAL
AMPLIFIER
DIGIT LEVEL
114
NEXT LEVEL
116
118
LEVEL SIGNAL
(HEIGHT)
AMPLIFIER

FIG.–13

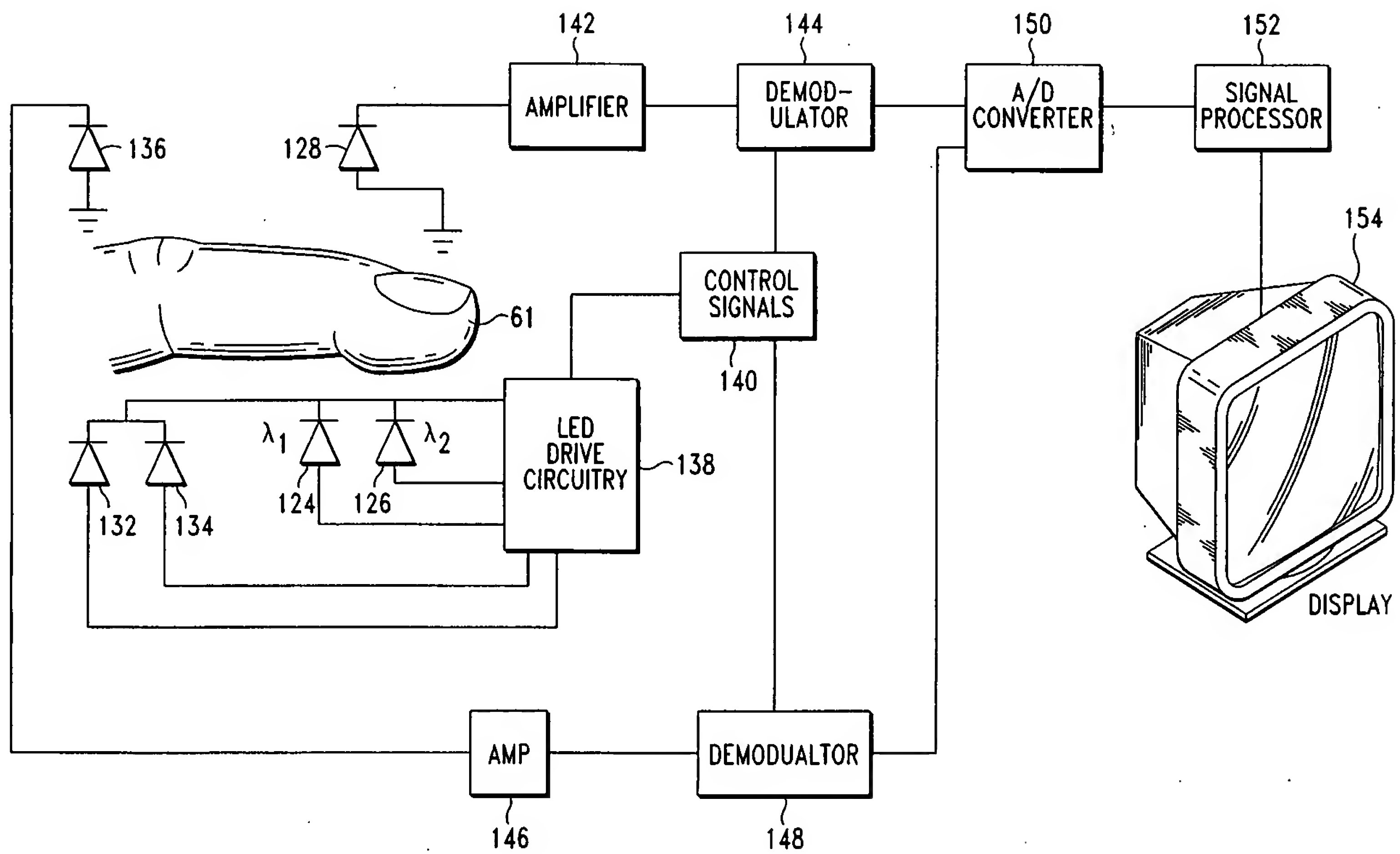

142
AMPLIFIER
144
DEMOD-
ULATOR
150
A/D
CONVERTER
152
SIGNAL
PROCESSOR
154
DISPLAY
136
128
61
CONTROL
SIGNALS
140
LED
DRIVE
CIRCUITRY
138
λ_1
λ_2
132
134
124
126
AMP
146
DEMODUALTOR
148

FIG.-14

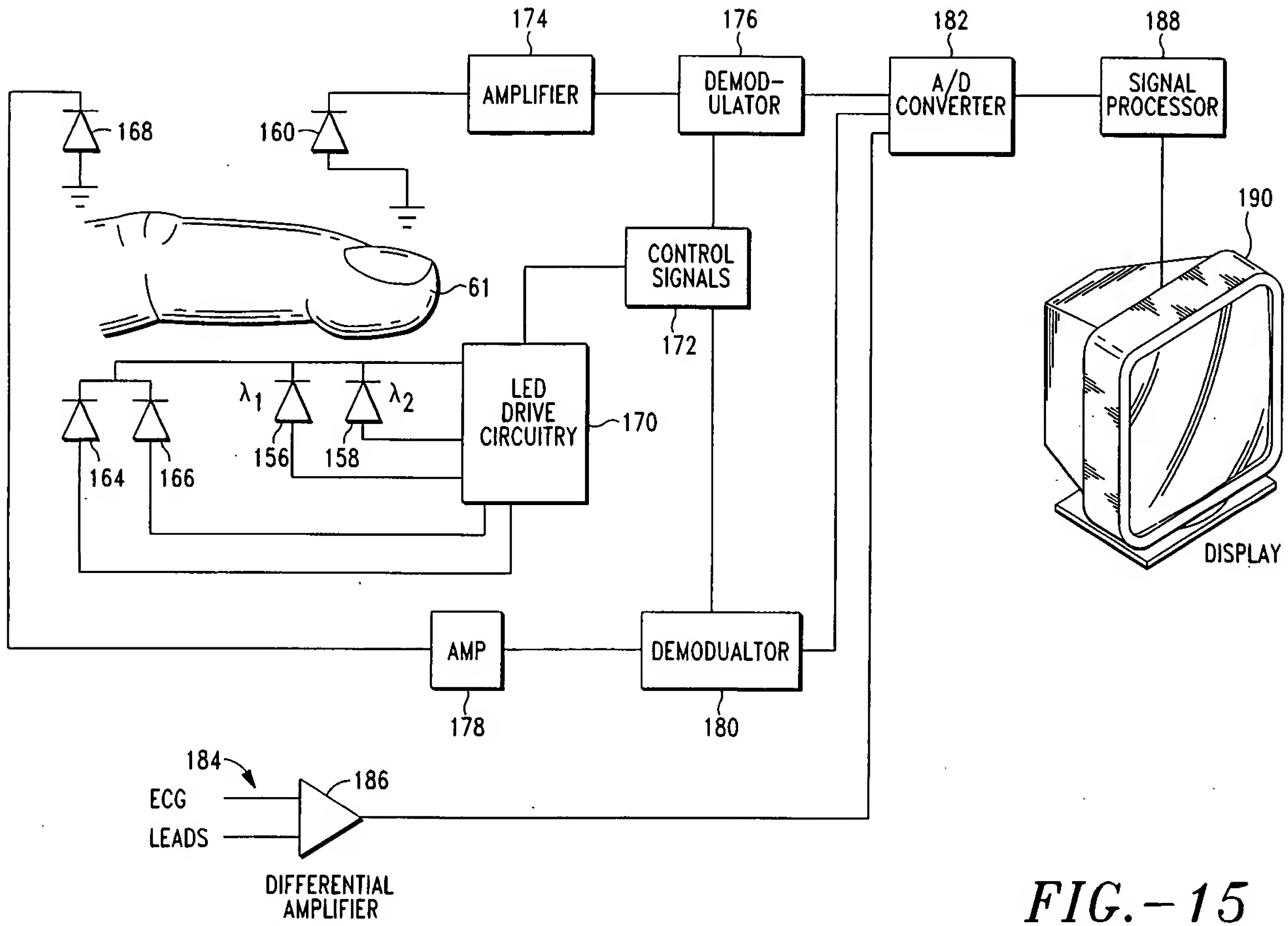

174
AMPLIFIER
176
DEMOD-
ULATOR
182
A/D
CONVERTER
188
SIGNAL
PROCESSOR
190
DISPLAY
168
160
61
CONTROL
SIGNALS
172
LED
DRIVE
CIRCUITRY
170
λ1
λ2
156
158
164
166
AMP
178
DEMODUALTOR
180
184
ECG
LEADS
186
DIFFERENTIAL
AMPLIFIER

FIG.-15

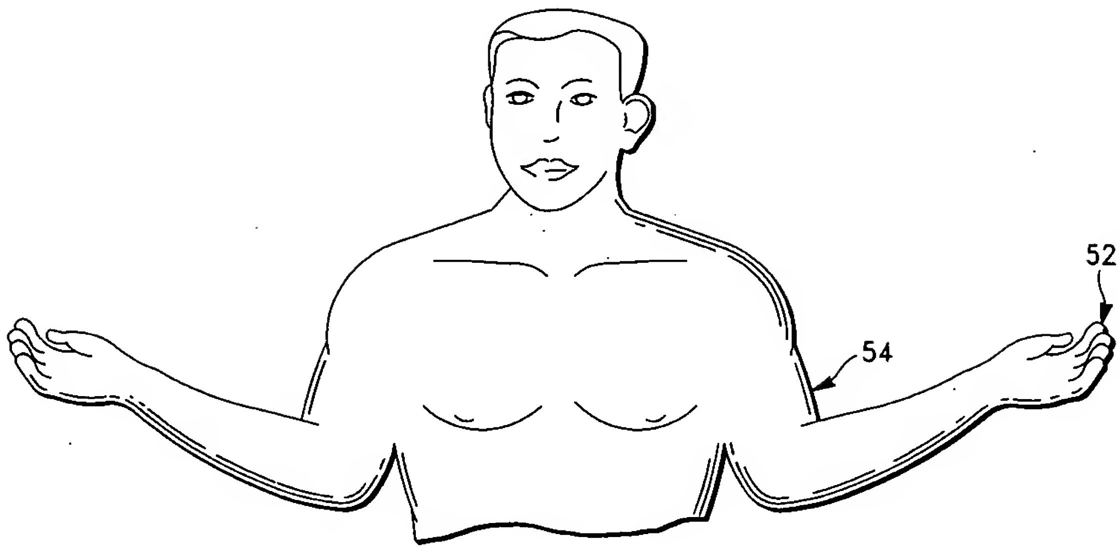


FIG.–16

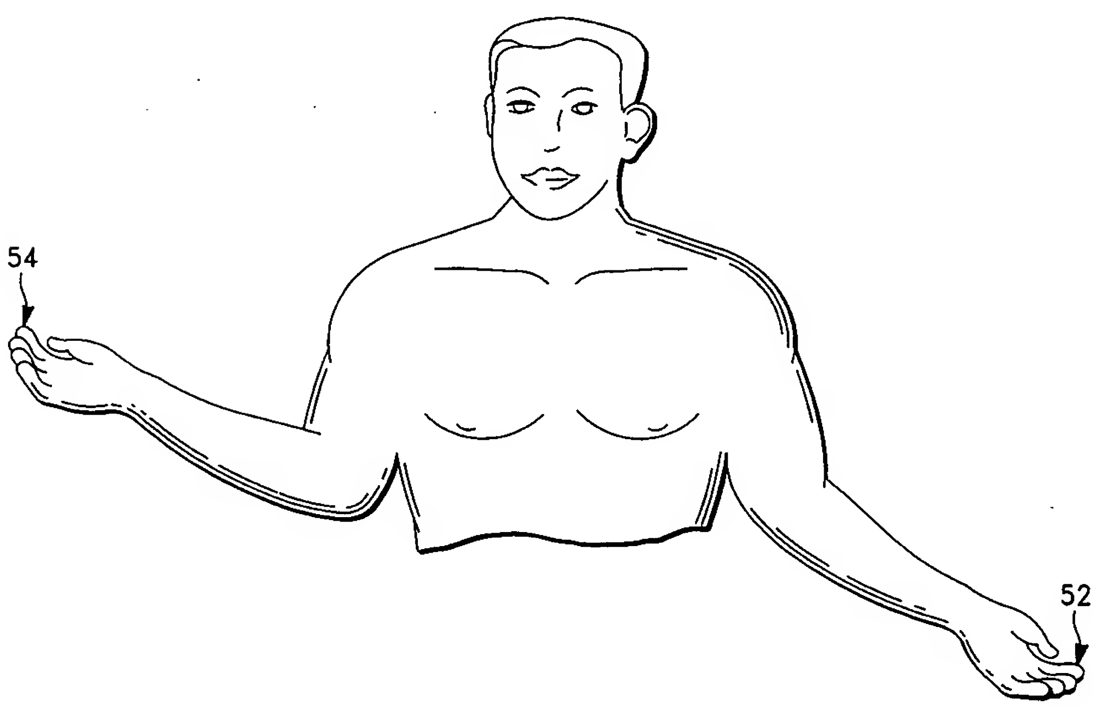


FIG.–19

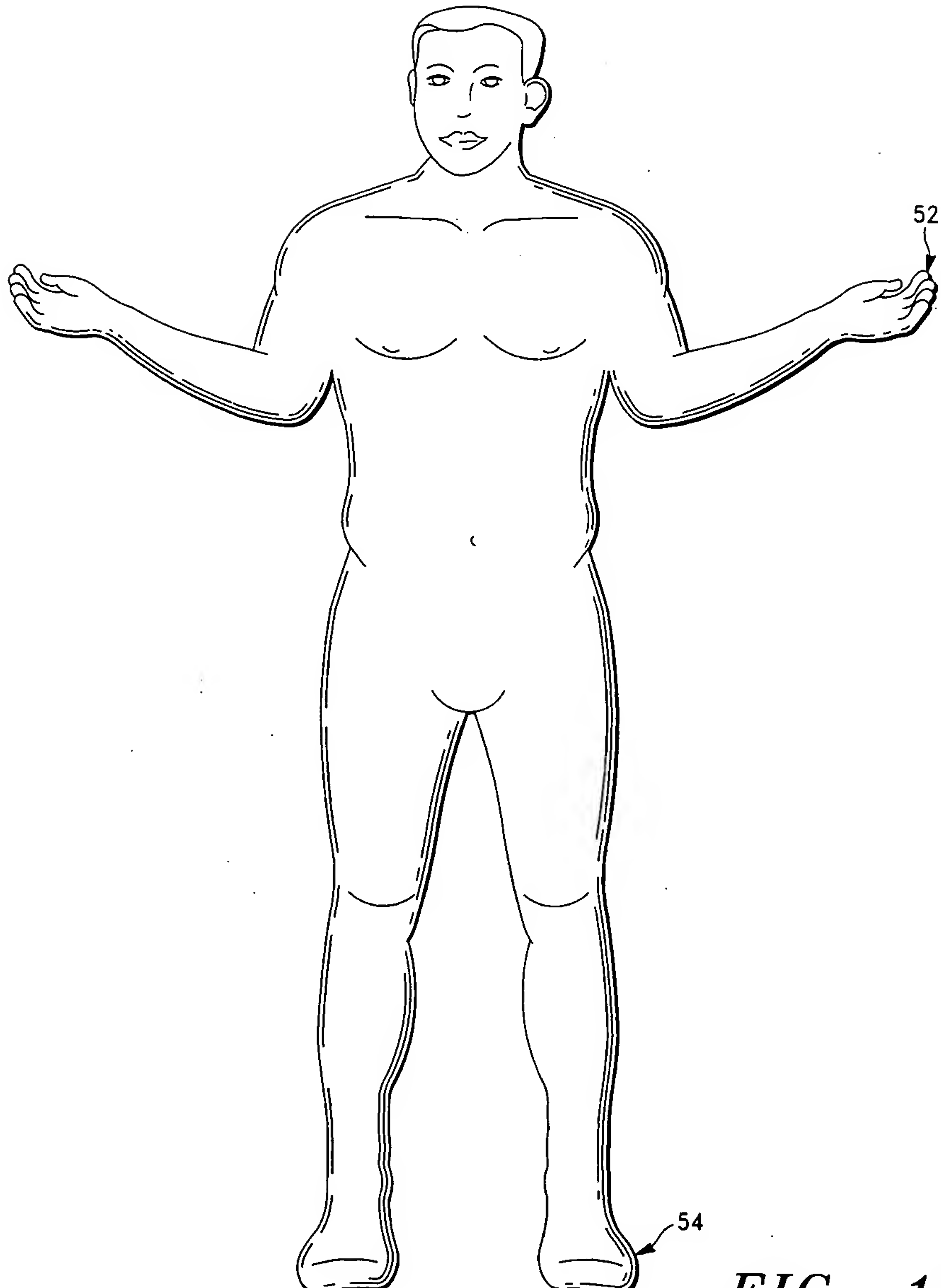


FIG.-17

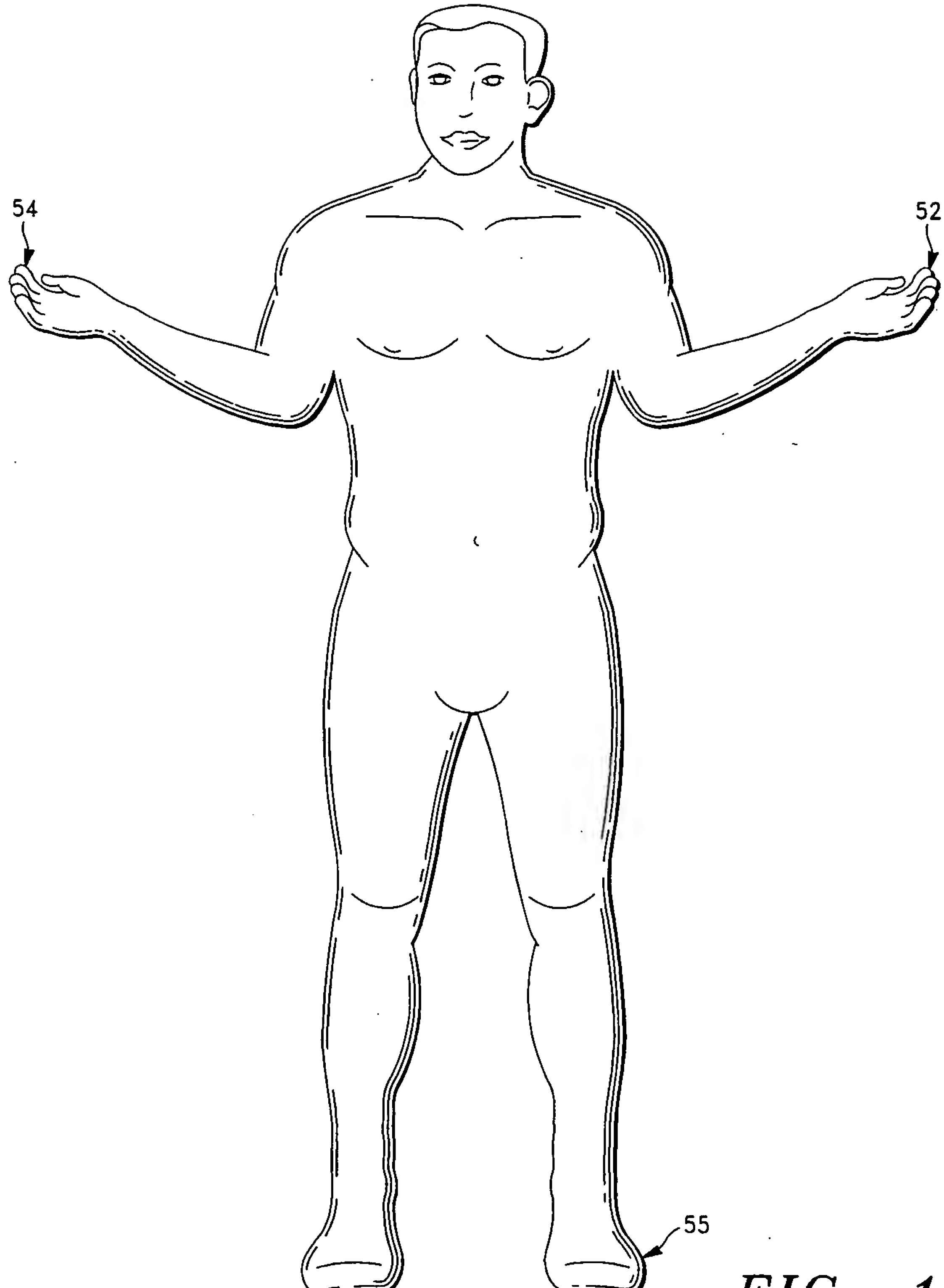


FIG.—18

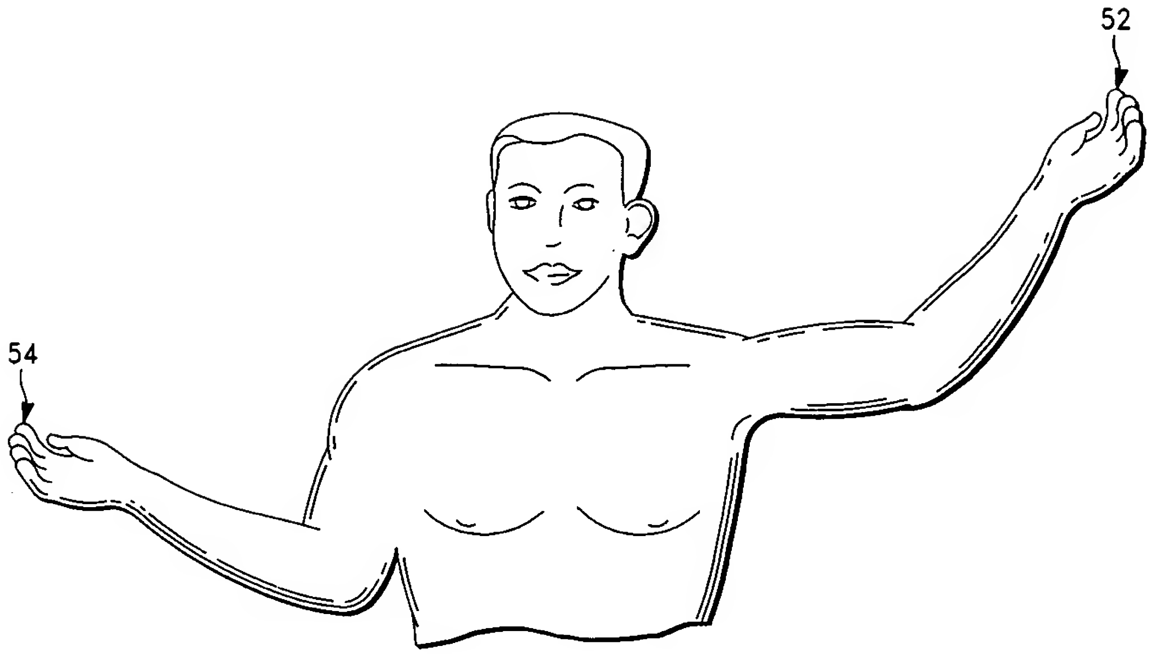


FIG.–20

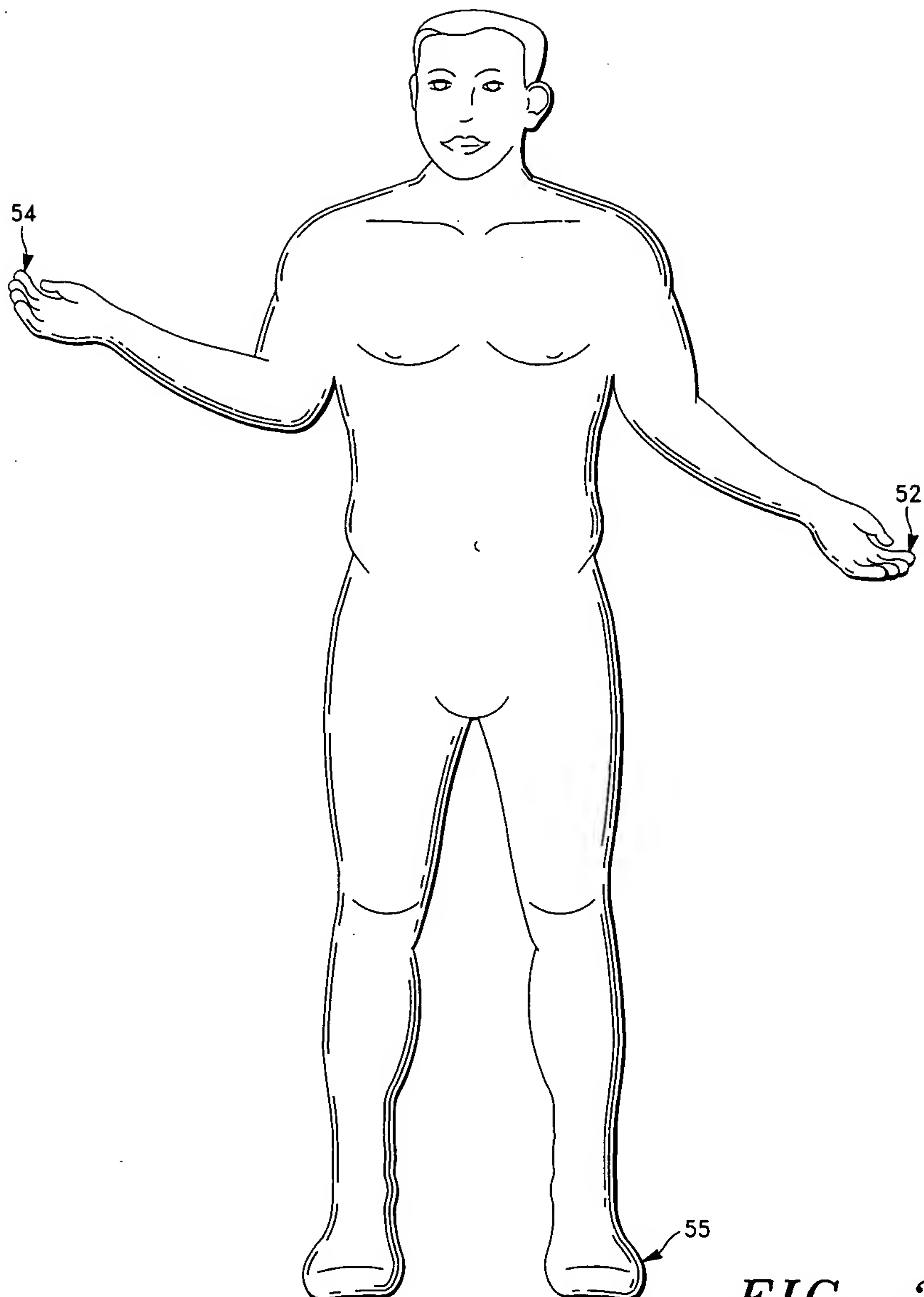


FIG.–21

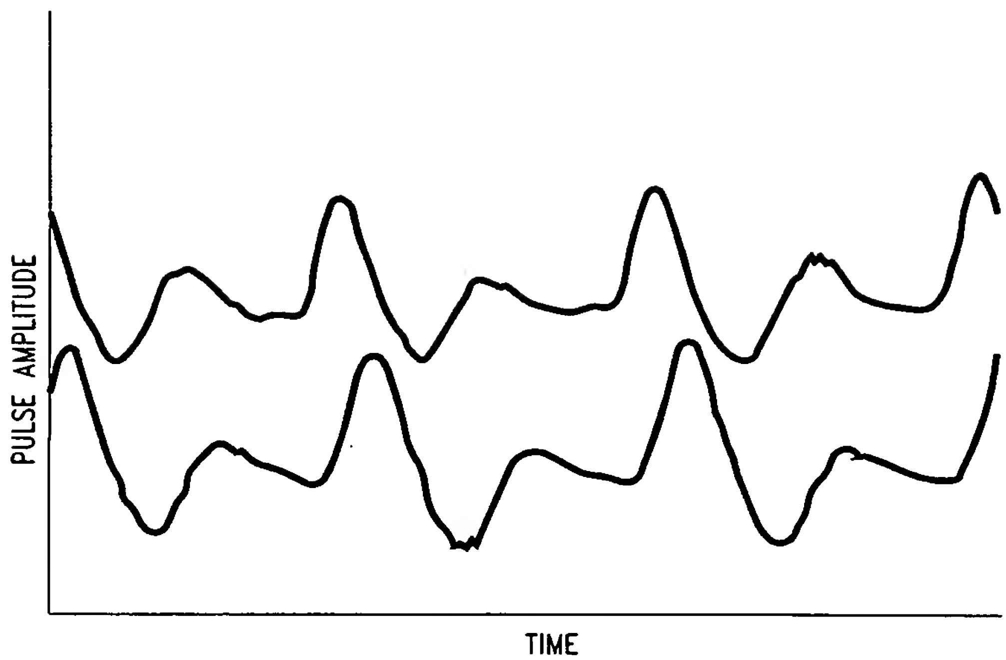


FIG.—22

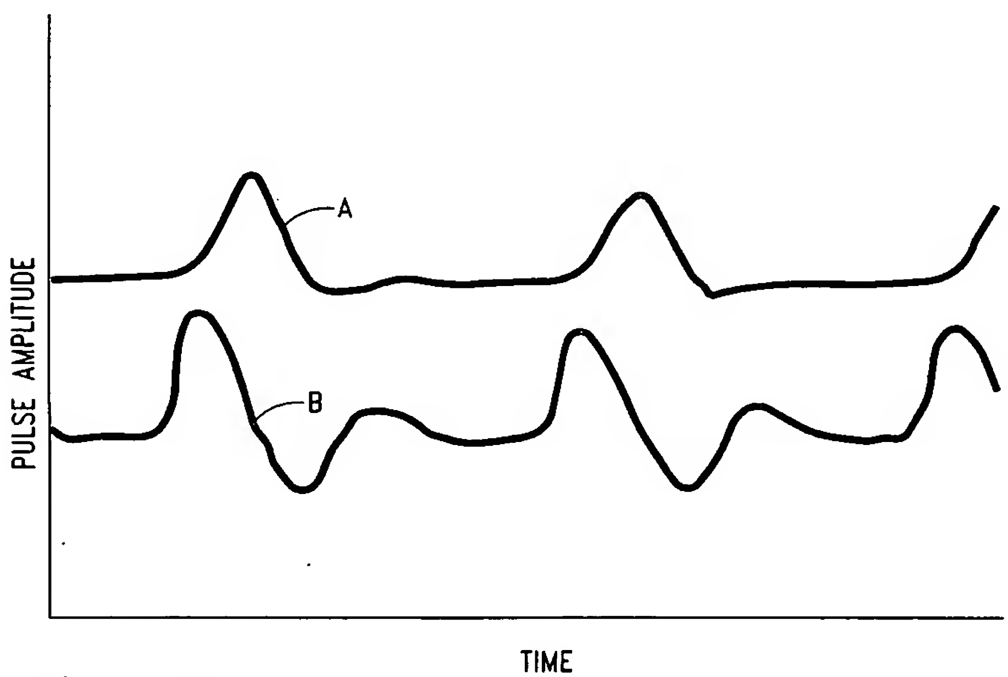


FIG.—23

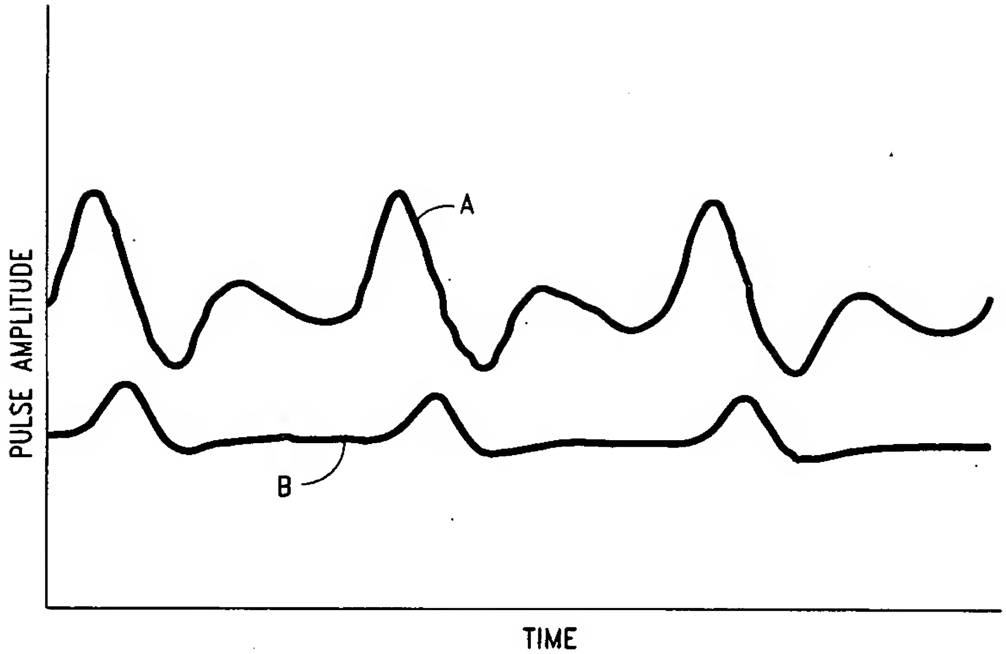


FIG.–24

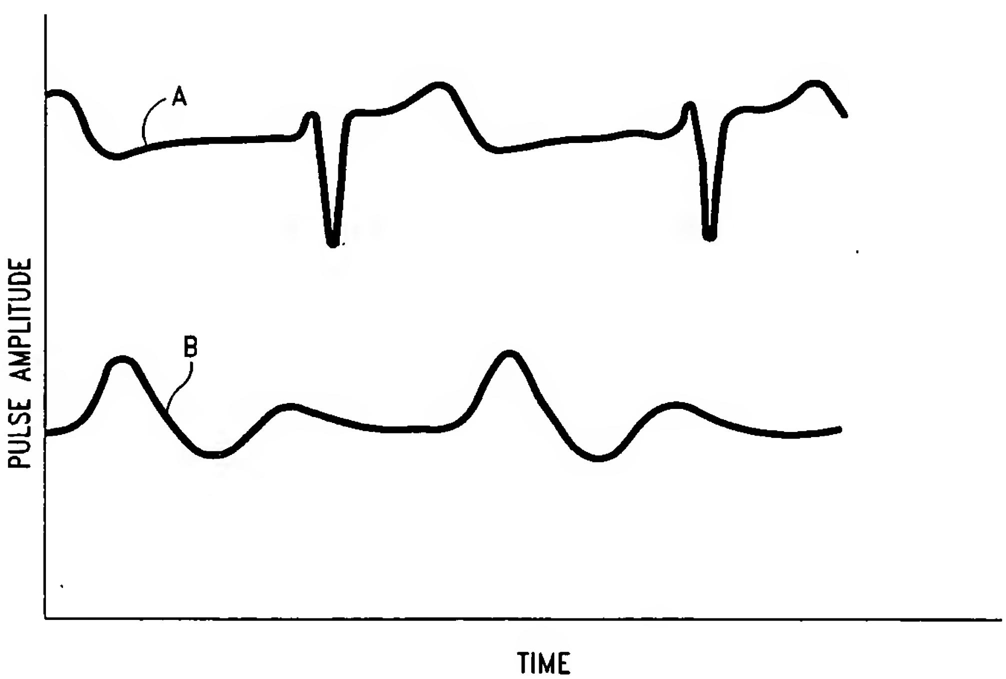


FIG.–25

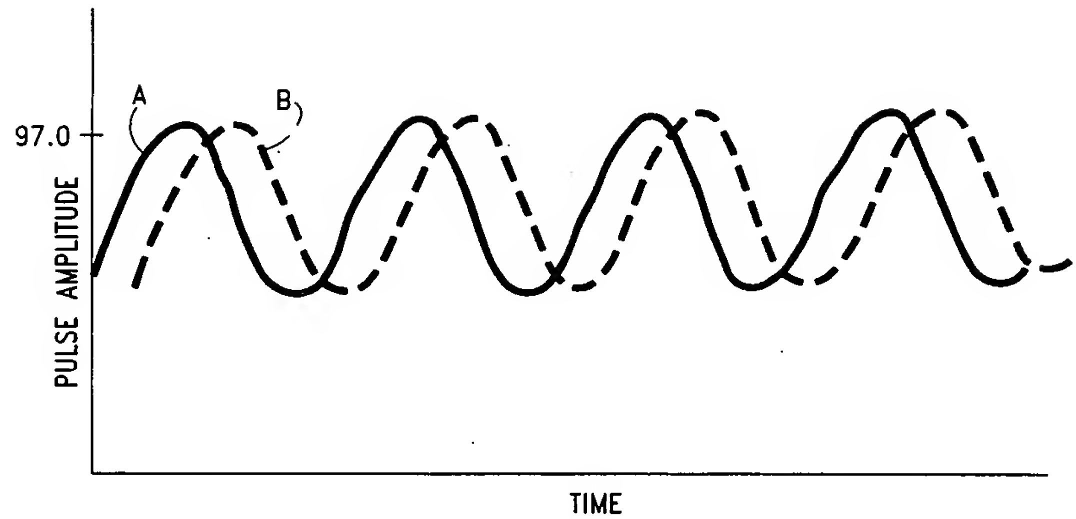


FIG.–26

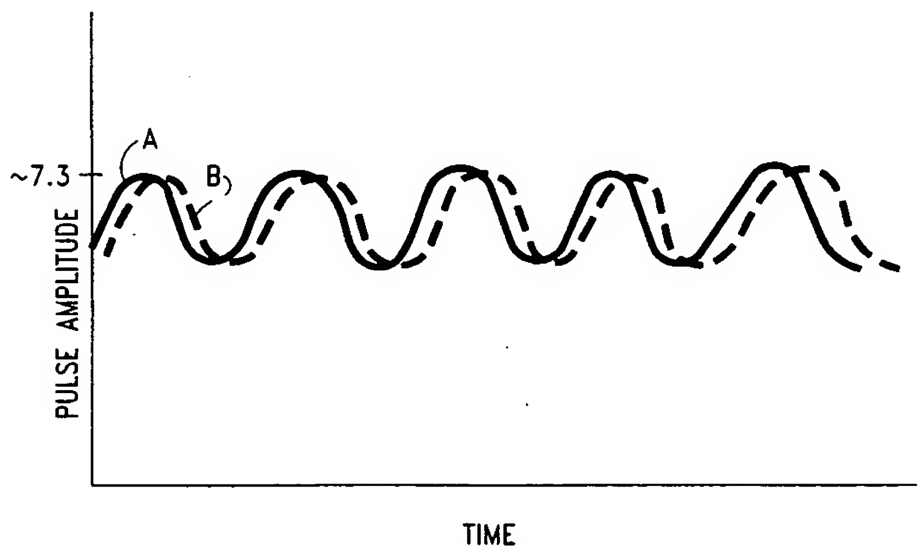
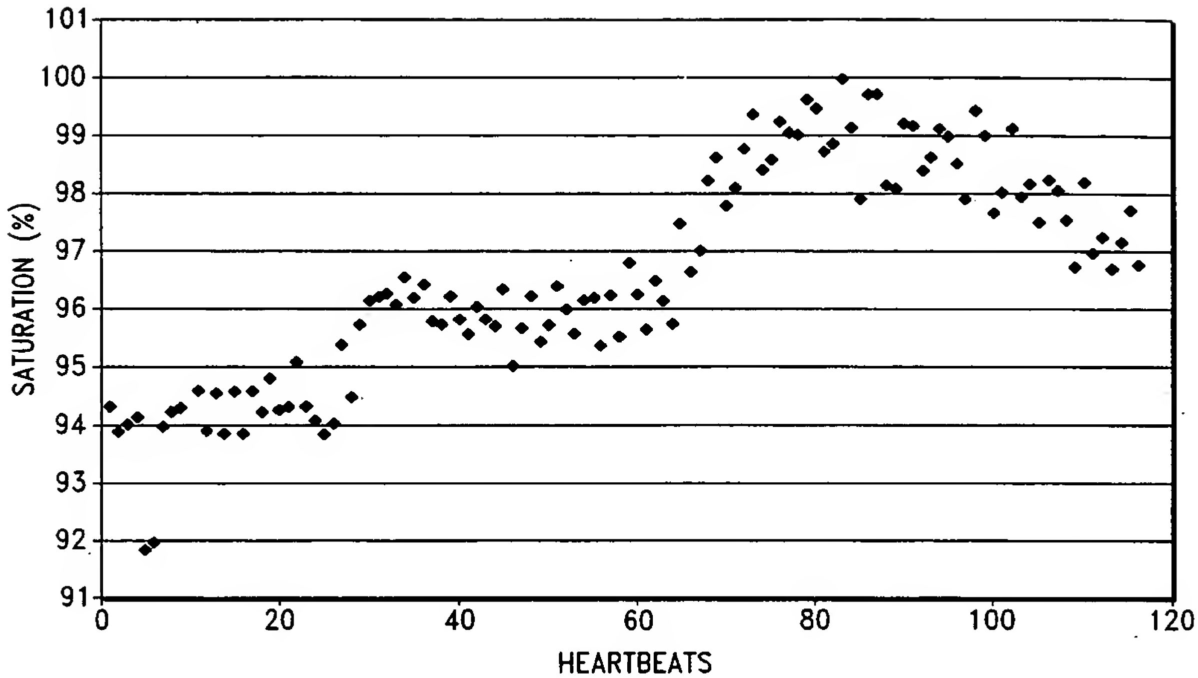
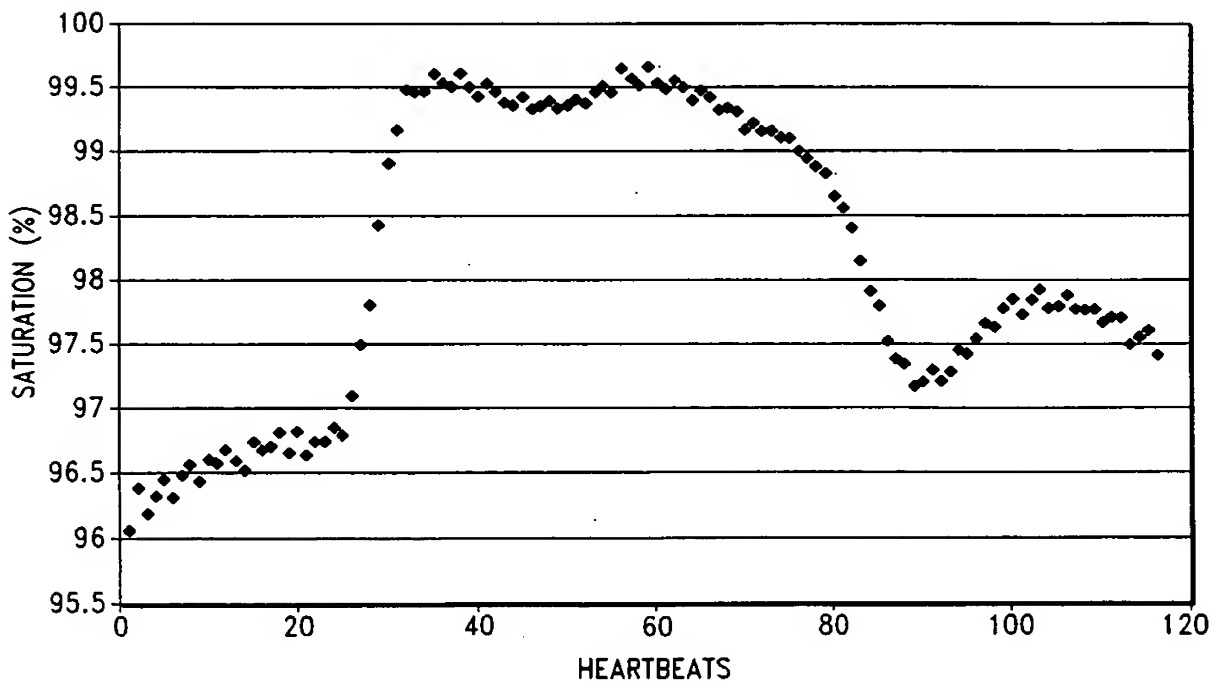


FIG.–27



101
100
99
98
97
96
95
94
93
92
91
SATURATION (%)
0
20
40
60
80
100
120
HEARTBEATS

FIG.–28



100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
SATURATION (%)
0
20
40
60
80
100
120
HEARTBEATS

FIG.–29

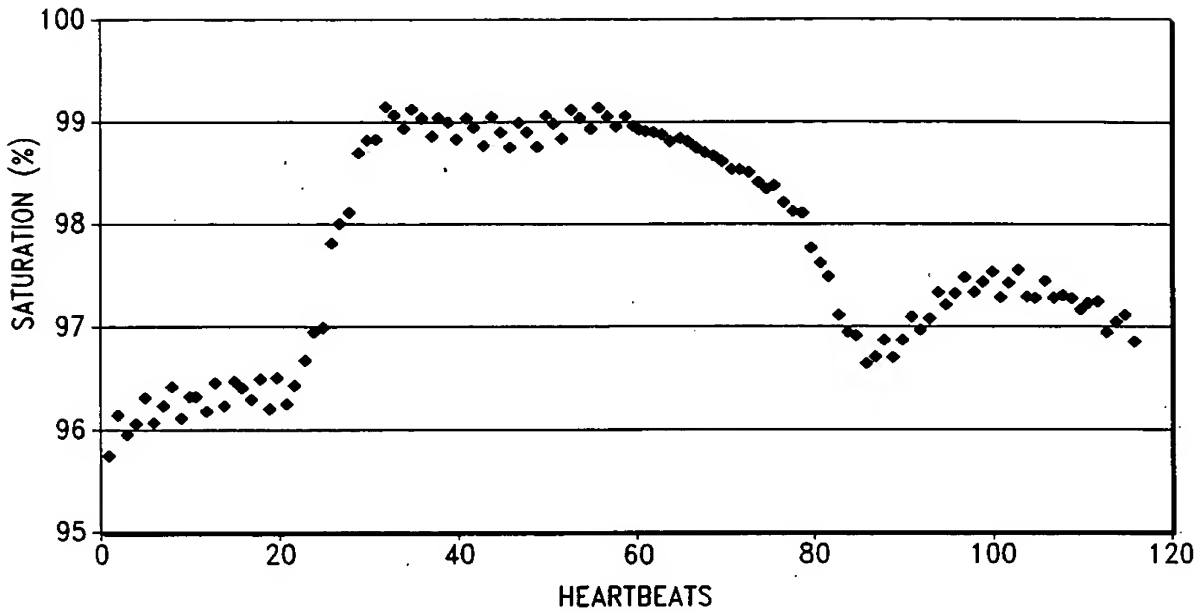

100
99
98
97
96
95
SATURATION (%)
0
20
40
60
80
100
120
HEARTBEATS

FIG.—30

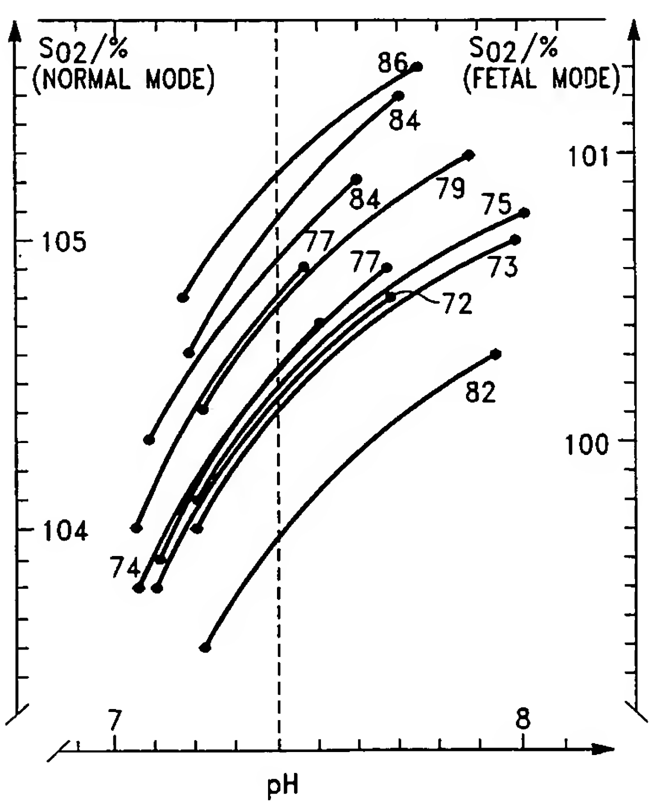

S02/%
(NORMAL MODE)
S02/%
(FETAL MODE)
105
104
101
100
86
84
84
79
75
77
77
72
73
82
74
7
8
pH

FIG.—31

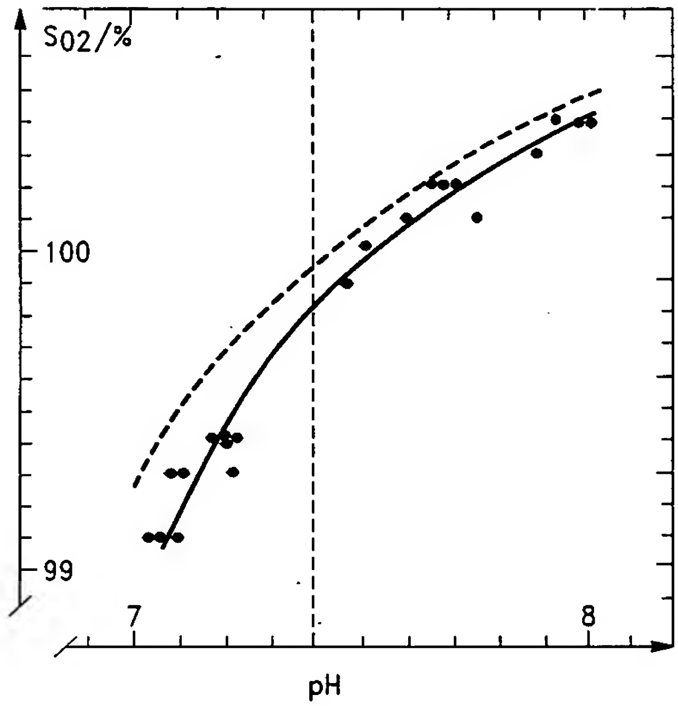

SO2/%
100
99
7
8
pH

FIG.–32

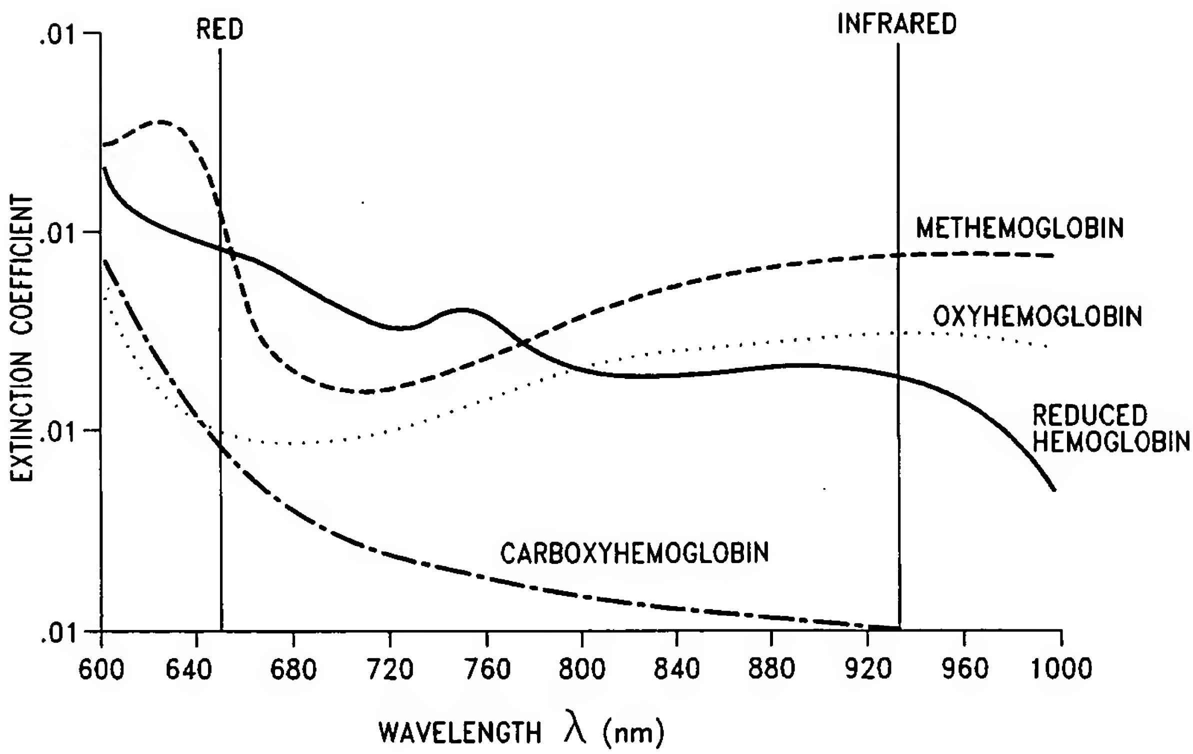
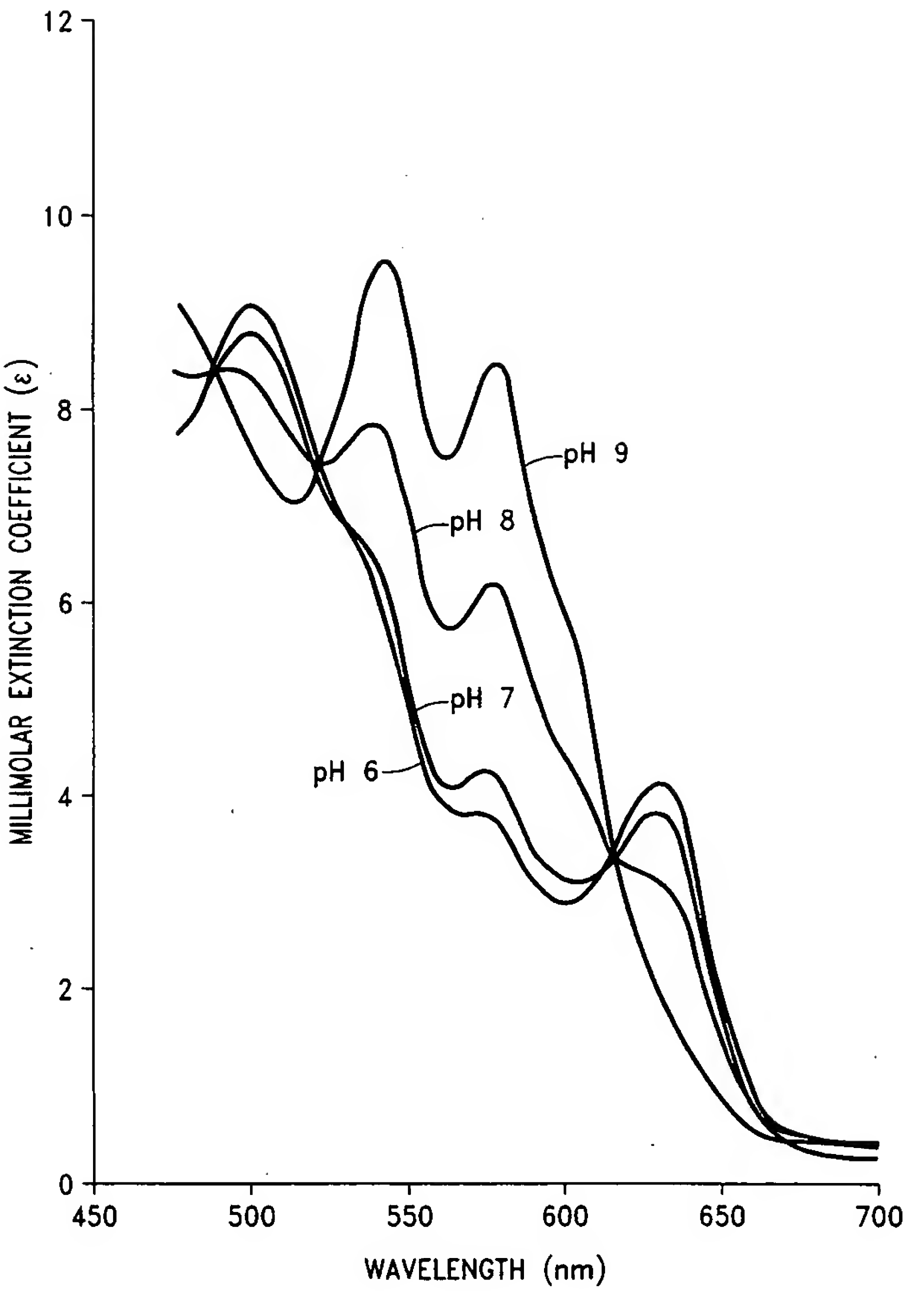

.01
.01
.01
.01
RED
INFRARED
METHEMOGLOBIN
OXYHEMOGLOBIN
REDUCED HEMOGLOBIN
CARBOXYHEMOGLOBIN
EXTINCTION COEFFICIENT
600
640
680
720
760
800
840
880
920
960
1000
WAVELENGTH λ (nm)

FIG.–34

Computational Algorithm for Determination of Hemoglobin Concentration

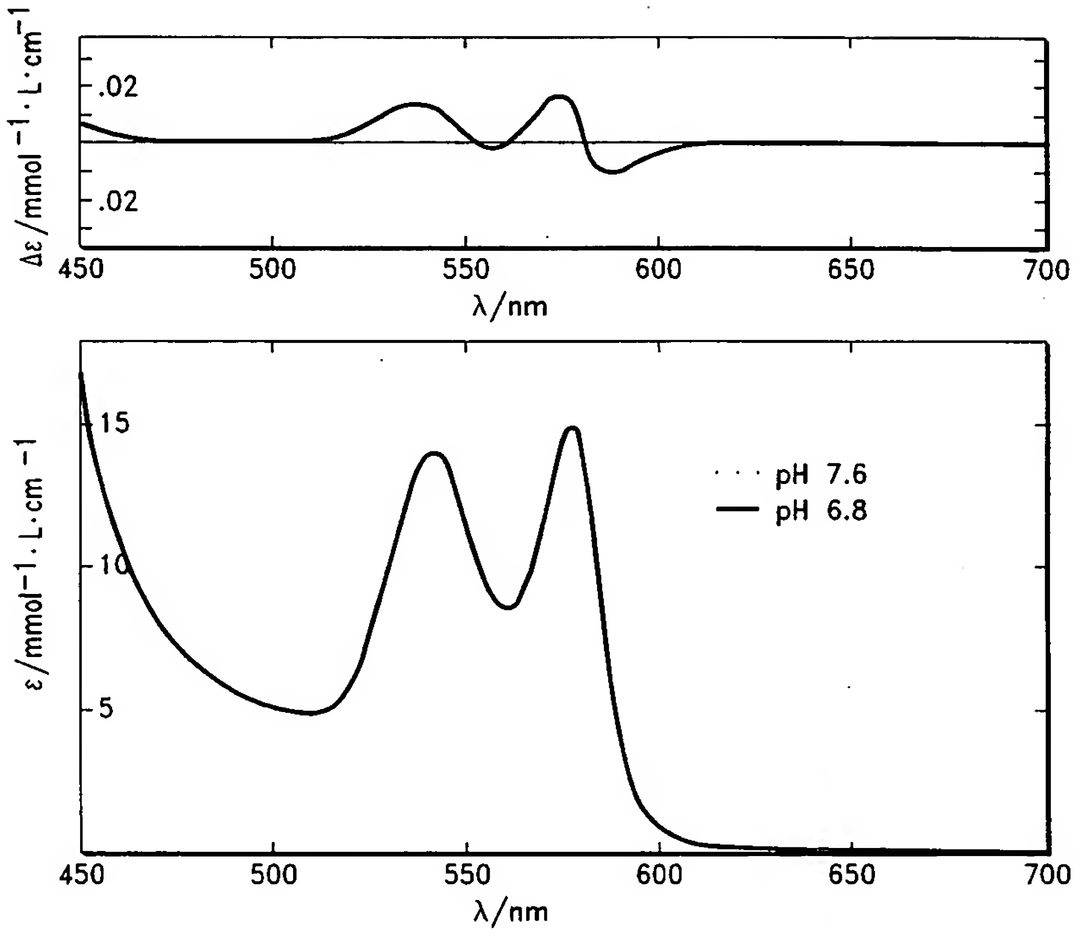
```
C       A  is the measured absorbance
C       A1  is the absorbance after dividing out extinction coefficients
C       and correcting for saturation
C       A2,A3, ... will be the absorbances at different path lengths,
C       created by multiplying by constants
C       A1,A3, ... and L2,L3, etc.
        constant M2=0.9
        constant M3=0.8
        constant M4=0.7
        constant M5=0.6
        constant M6=0.5
        constant M7=0.4
        constant M8=0.3
C
C       read in the value for hemoglobin absorbance and a value k
C       representing the extinction coefficient for the wavelength and
C       the oxygen saturation
        Begin
        Read, A
        Read, k
        A1:=A/k
        A2:=A1*M2
        A3:=A1*M3
        A4:=A1*M4
        A5:=A1*M5
        A6:=A1*M6
        A7:=A1*M7
        A8:=A1*M8
C
        k1234 = log(A1) * log(A2) - log(A3) * log(A4)
        k5678 + log(A5) * log(A6) - log(A7) * log(A8)
        kd:=[ log(A1*A2) - log(A3*A4) ] / [ log(A5*A6) - log(A7*A8) ]
C
C       combine all the A terms that occur as coefficients,
        kAc := log(A2/A1) - log(A3/A1) - log(A4/A1) - [(kd * log(A5/A1)] -
              - [kd * log(A6/A1) + [kd * log(A7/A1)] + [kd * log(A8/A1)]
C
C       combine all the A terms that occur alone
        kAa :=- [log(A3/A1) * log(A4/A1)] ) -
                    - kd * [log(A5/A1) * log(A6/A1)] +
                    + kd* [(log(A7/A1) * log(A8/A1)]
C
C       k1234 - ( kd * k5678) = kig(L) * kAc + kAa
C       log(L) = [k1234 - (kd * k5678) - kAa] / kAc
C       L = antilog{[k1234 -(kd * k5678) - kAa] / kAc}
C       use EXP or antilog function
        L = EXP([k1234 - (kd * k5678) - kAa] / kAc)
C       L is the path length
C       C is the concentration of hemoglobin
        C = A1 / L
C
        END
```

FIG.—33



12
10
8
6
4
2
0
MILLIMOLAR EXTINCTION COEFFICIENT (ε)
450
500
550
600
650
700
WAVELENGTH (nm)
pH 9
pH 8
pH 7
pH 6

FIG.–35



Δε/mmol −1 . L·cm −1
.02
.02
450
500
550
600
650
700
λ/nm
ε/mmol−1. L·cm −1
15
10
5
pH 7.6
pH 6.8
450
500
550
600
650
700
λ/nm

FIG.–36

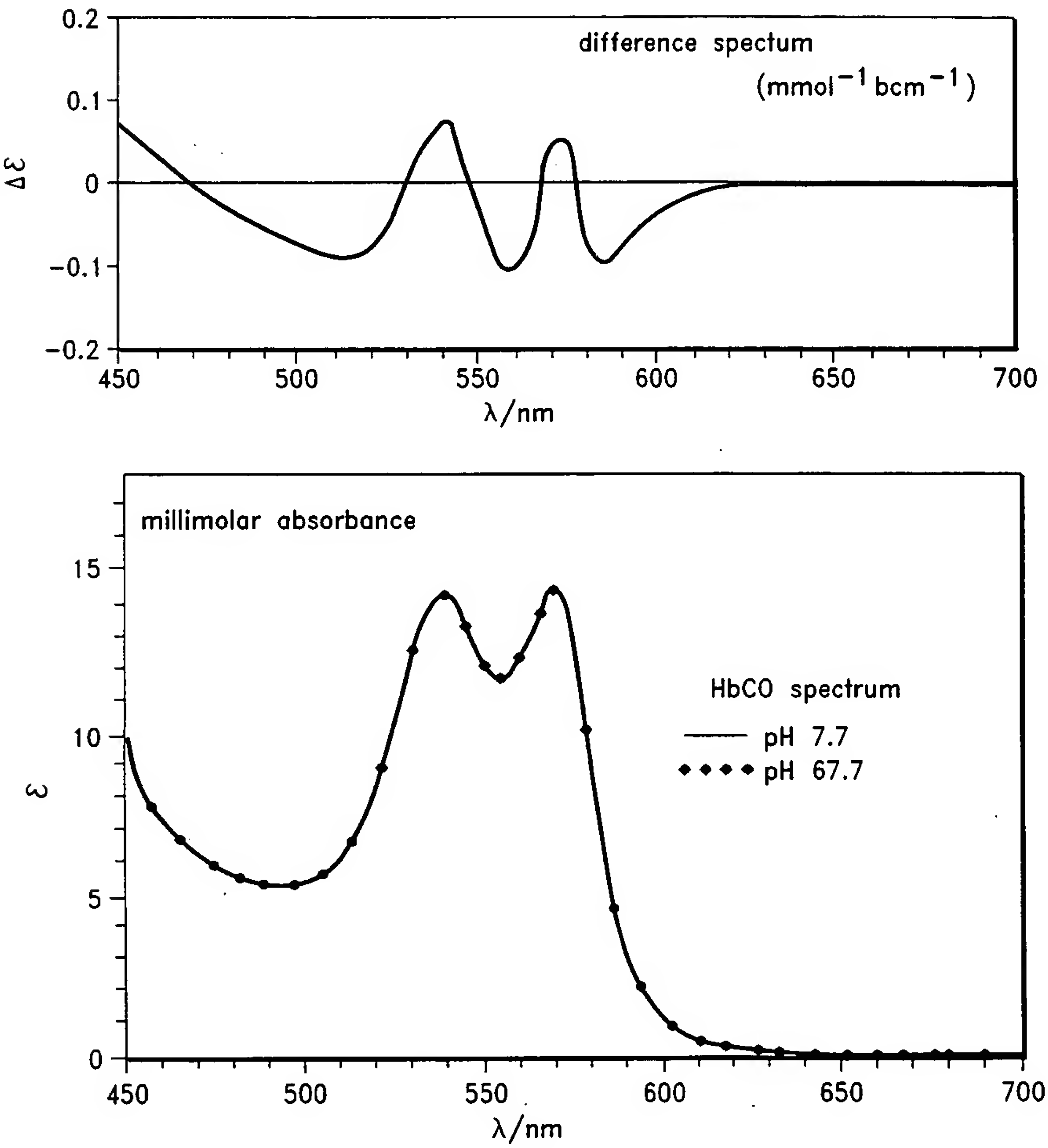
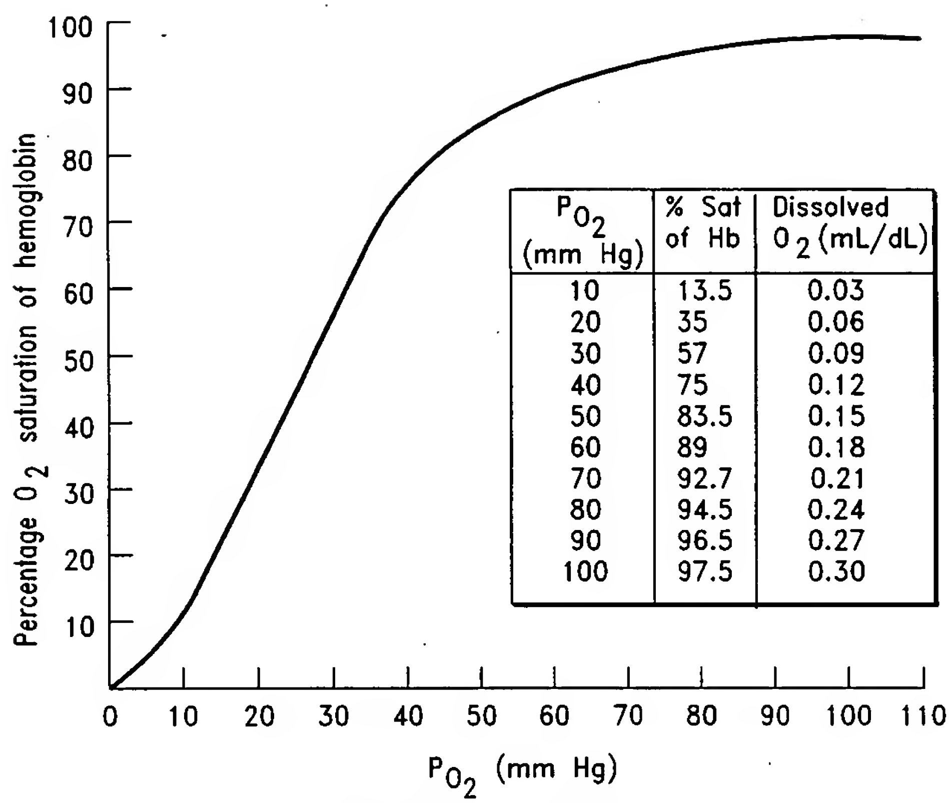

difference spectum
(mmol−1 bcm−1)
Δε
0.2
0.1
0
−0.1
−0.2
450
500
550
600
650
700
λ/nm
millimolar absorbance
HbCO spectrum
pH 7.7
pH 67.7
ε
15
10
5
0
450
500
550
600
650
700
λ/nm

FIG.−37



P_{O_2} (mm Hg)	% Sat of Hb	Dissolved O_2 (mL/dL)
10	13.5	0.03
20	35	0.06
30	57	0.09
40	75	0.12
50	83.5	0.15
60	89	0.18
70	92.7	0.21
80	94.5	0.24
90	96.5	0.27
100	97.5	0.30

FIG.–38

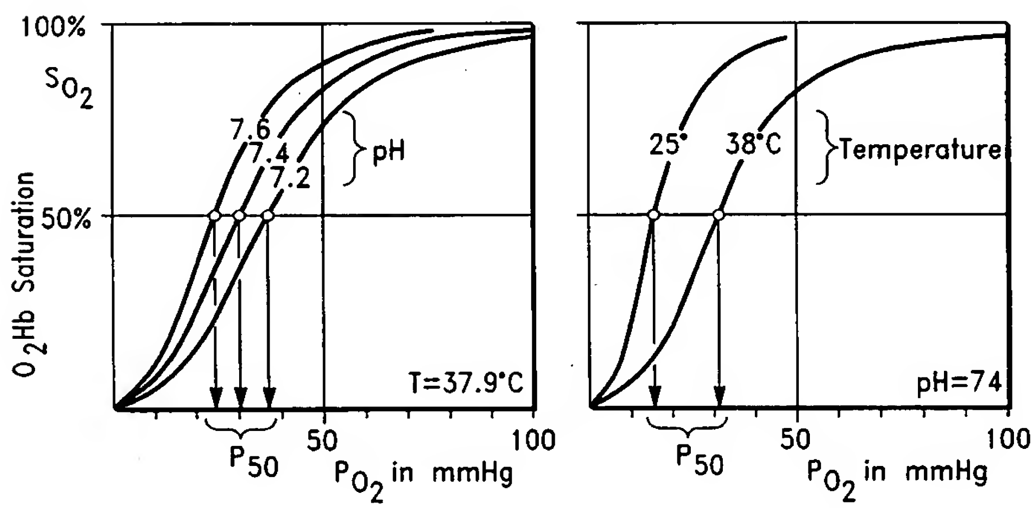


FIG.–39

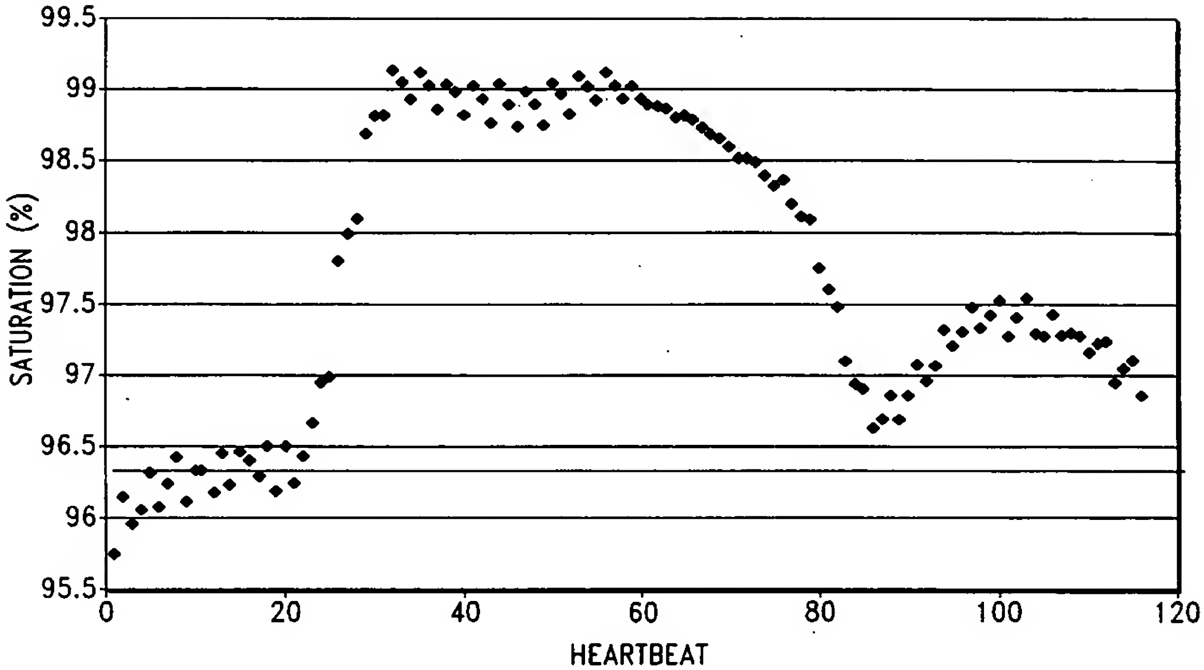

99.5
99
98.5
98
97.5
97
96.5
96
95.5
SATURATION (%)
0
20
40
60
80
100
120
HEARTBEAT

FIG.—40

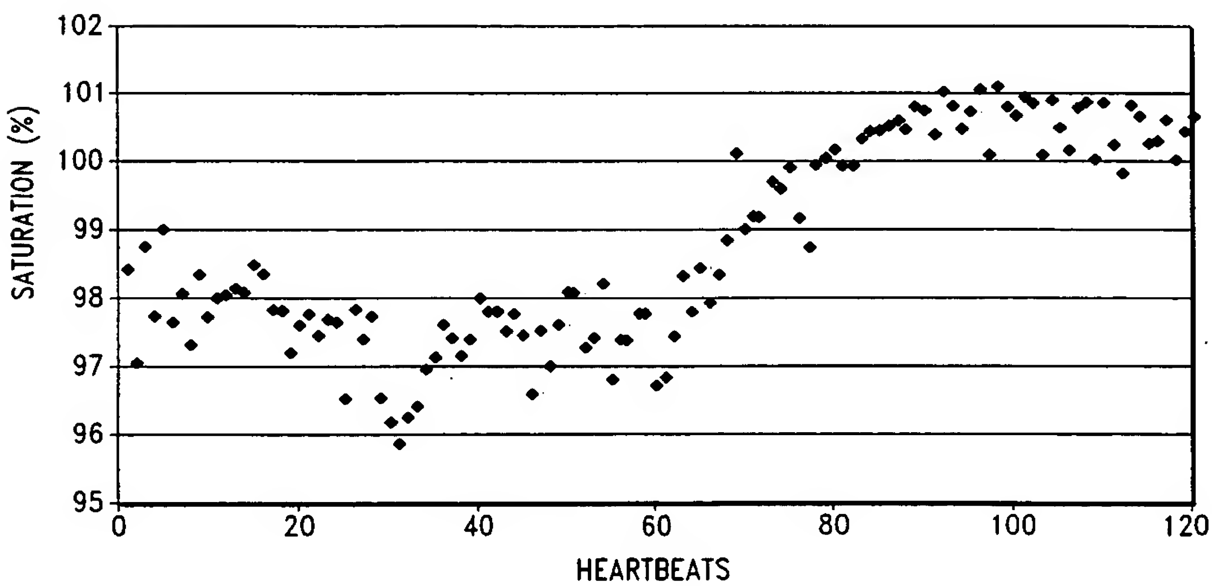

102
101
100
99
98
97
96
95
SATURATION (%)
0
20
40
60
80
100
120
HEARTBEATS

FIG.—41